Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

# IMBEDDED SEXUAL CELLS IN THE POLYPODIACEAE

MARGARET C. FERGUSON

(WITH PLATES XXVI AND XXVII)

About five years ago an assistant in the botanical laboratories of Wellesley College, Miss ANN REBECCA TORRENCE, was asked to prepare a set of slides, illustrating the development of the sexual organs in the ferns, for general class use. In looking over the slides which she had marked as valueless, I found several preparations showing an unusual origin of the egg cells. These slides were put aside with the expectation of publishing a note in the near future.

In February 1910, Miss JEAN WINSLOW, a student in my advanced course in cytology and comparative morphology, was puzzled by certain structures which she found in several of her preparations. The material was fixed and prepared for study by the student herself under the direction of the laboratory assistant, Miss EMILY P. LOCKE. Upon examining her slides, I found that they contained numerous instances of imbedded antheridia.

The fern prothallia used for class purposes are grown by the gardener. He sows, in clay saucers containing especially prepared soil, the spores of *Pteris* and *Adiantum*, some dishes containing only spores of *Pteris* and others containing spores of *Adiantum*. In both instances the structures about to be described were taken from cultures marked "Pteris," probably *Pteris cristata;* but since the spores of other species of *Pteris* are sometimes sown, I cannot state definitely the exact species of *Pteris* which was studied.

When the imbedded antheridia were discovered, I looked up the slides showing the deep-seated origin of eggs in *Pteris*, and we had a very interesting class demonstration and discussion.

At that time I said to the class that similar phenomena had never before been seen in a leptosporangiate fern; at least, if seen, the observations had never been published. Within a week I had made the drawings which appear in connection with this note, but was detained from writing at that time. A little later, in looking over some back numbers of the current botanical literature, I ran across Miss BLACK's paper describing imbedded antheridia in *Dryopteris* and *Nephrodium*.[1] It is interesting that with no knowledge of Miss BLACK's work I had come to practically the same conclusion as that outlined in her paper regarding the origin and development of these unusual structures. I publish herewith exactly the same figures, without change or addition, as were prepared before Miss BLACK'S paper was read. No prothallium containing unusual sexual organs was studied that did not also show normal archegonia and antheridia in all stages of development.

There can be no question as to the presence of an imbedded antheridium in these leptosporangiate ferns very similar to that found in the eusporangiates. Compare figs. 11 and 12 of this paper with Campbell's figs. 125 *D*, 128 *B*, 152 *D*.[2] The origin of these antheridia is not so obvious. There is no doubt that, as described by Miss BLACK, they may have practically the same origin as archegonia, but they may present transitional stages between normal antheridia and archegonia. Fig. 1 shows a normal young antheridium in which the first wall formed was not sufficiently concave to reach the basal wall, as is ordinarily but not invariably the case. Had the initial cell failed to protrude before the laying down of this cross-wall, such a structure would have been formed as that shown in fig. 2. Here the second wall formed, the dome-shaped cell, is much more prolonged than is usual. But the protrusion of the outer cell may be much less (fig. 3), or there may be no arching at all (fig. 4), when we would have what is recognized as an early stage in the development of a normal archegonium. Miss BLACK finds that arching occurs only in later stages of development, but in *Pteris* there is undoubtedly a greater or less arching of the initial cell in many cases, as if it were undecided as to whether it should be an antheridium or an archegonium; but the arching in such cases is insufficient to make the resulting organ completely superficial.

---

[1] BLACK, CAROLINE A., The development of the embedded antheridium in *Dryopteris stipularis* (Wild.) Maxon and "*Nephrodium molle*." Bull. Torr. Bot. Club **36**: 557. 1909.

[2] CAMPBELL, D. H., Mosses and ferns. New York. 1905.

The first wall laid down in the development of the imbedded antheridium is in the same plane as under normal conditions, but it may be deep-seated and little or not at all saucer-shaped (figs. 2, 3, 5). The second wall cuts out a central cell which may be very dome-shaped or may not be arched at all (figs. 2, 3, 5, 7, 8). The third wall follows in normal succession, cutting out the cover cell (figs. 5, 7, 8). The divisions occurring in the central cell of these antheridia in *Pteris* are somewhat different from those occurring in *Dryopteris* and *Nephrodium* as described by Miss Black. The first wall may sometimes be anticlinal and divide the cell into two equal cells, as is true under normal conditions (fig. 9*a*); but in the majority of cases observed the central cell of the entirely sunken antheridium was divided by two slightly oblique anticlinal walls into three cells lying in the same plane (figs. 7, 8).

Later stages in the development of the antheridium could not be traced beyond a question in the material at hand. But sooner or later a mass of cells occurs, from which the sperms are eventually produced. In order to meet the needs of the enlarged antheridium the one cover cell is replaced by a cell complex. As a rule, the mature imbedded antheridium is covered by a single layer of cells, but it may become two cells deep (fig. 10). In all cases observed, the imbedded antheridium is surrounded by a layer of cells much smaller than those which form the venter of an archegonium in the ferns, suggesting very strongly in their arrangement and appearance tapetal cells (figs. 10–12).

The size of the young, partially imbedded antheridia is practically the same as that of the normal antheridia, as is seen by a comparison of figs. 1 and 3, and figs. 5 and 6. But in later stages of development these unusual antheridia may become greatly enlarged. The more deeply sunken the antheridium the greater the size is apt to be at maturity. A normal, mature antheridium is shown in fig. 13. Compare this both as to position and size with the antheridia illustrated in figs. 11 and 12. Fig. 12 does not represent the largest antheridium observed. It was figured rather to show that these organs not only may not protrude but that the cover cells may actually be depressed. Several antheridia much larger than this were observed. The sperm cells, while perfectly normal in appearance, are considerably larger than those developed under the usual conditions.

Imbedded antheridia were not found on the prothallia showing an unusual origin of the egg cells. In the case of the archegonia, the most frequent deviation from the normal gave two egg and two ventral canal cells lying in the plane of the longer axis of the archegonium (fig. 15). There is little doubt in this case that the more deeply imbedded egg and ventral canal cell were derived from the basal cell of the young archegonium. Ordinarily this cell contributes to the formation of the venter of the archegonium. In several instances the basal cell contained a beautiful, spherical mass of dense cytoplasm with a large nucleus, presenting the appearance of a large central cell before its division to form the ventral canal cell and the egg cell (fig. 14). The preparations studied showed egg cells that were unquestionably derived from other cells of the venter, but in these instances the sections were cut at such an angle as to render the figures unfavorable for reproduction.

There is no evidence that these deep-seated eggs or the imbedded antheridia were developed in response to dryness, as was the case in Miss BLACK's material. The two prothallia containing each seven or eight abnormal antheridia and the three prothallia showing several deep-seated eggs occurred in cultures from which a large amount of material was put up, and no other prothallia showed any deviation from the normal. Of course the fact remains that these particular prothallia may have been in positions of especial exposure, but, considering the method of culturing the prothallia, this is not probable.

I shall not enter into a prolonged discussion of the significance of these structures, since this has been so recently and so ably done by Miss BLACK. I wish simply to emphasize the point which she makes regarding the bearing of these phenomena on the question of the determination of sex in monoecious prothallia, and on the problem of vegetative fusion as described by recent writers.

In this connection the condition represented in fig. 9*b* is very interesting. Here we have apparently the first three cells of an archegonium, in which the central cell has developed directly into what is to all appearances a sperm cell. This leads us to inquire at what point in the development of a prothallium the sexual nature of its cells is determined. Are we not too much accustomed in our thinking to combine the idea of sexuality with form and position and definite organs? It may be that maleness and femaleness have no necessary relation to form or position or sexual organs, but that sperms and eggs are developed in relation to the sexual act or process, not as a necessary expression of sexuality. Should this be found to be true, then many cases of so-called vegetative fusion may come to be considered simply as instances of early or premature fertilization. To determine the point in the development of monoecious prothallia at which certain cells become endowed with sexuality, and the characteristic which makes them male or female, is one of the interesting but difficult problems which await solution.

WELLESLEY COLLEGE
WELLESLEY, MASSACHUSETTS

## EXPLANATION OF PLATES XXVI AND XXVII

Unusual conditions in the development of the antheridia and the archegonia in *Pteris*.

FIG. 1.—A young antheridium in which the first wall laid down is very slightly concave.

FIG. 2.—A young, partially imbedded antheridium; the first wall laid down is parallel with the basal wall and not at all concave, while the second wall is very greatly arched.

FIG. 3.—A similar stage to that shown in fig. 2, but the antheridium is more completely imbedded and the outer cell arches but slightly.

FIG. 4.—The three-celled stage either of a normal archegonium or of an imbedded antheridium.

FIG. 5.—A later stage in the development of a partially imbedded antheridium; the cover cell has been cut out in the usual manner.

FIG. 6.—A slightly later stage in the development of a normal antheridium.

FIGS. 7, 8.—Practically the same stage of partially or wholly imbedded antheridia as that shown in fig. 6; their position is entirely that of young archegonia.

FIG. 9*a*.—A later stage in the development of a partially imbedded antheridium; the first division of the central cell was evidently the same as under normal conditions.

FIG. 9*b*.—An early stage in the development of a normal archegonium or of an imbedded antheridium; in this case the central cell has apparently given rise directly to a sperm cell.

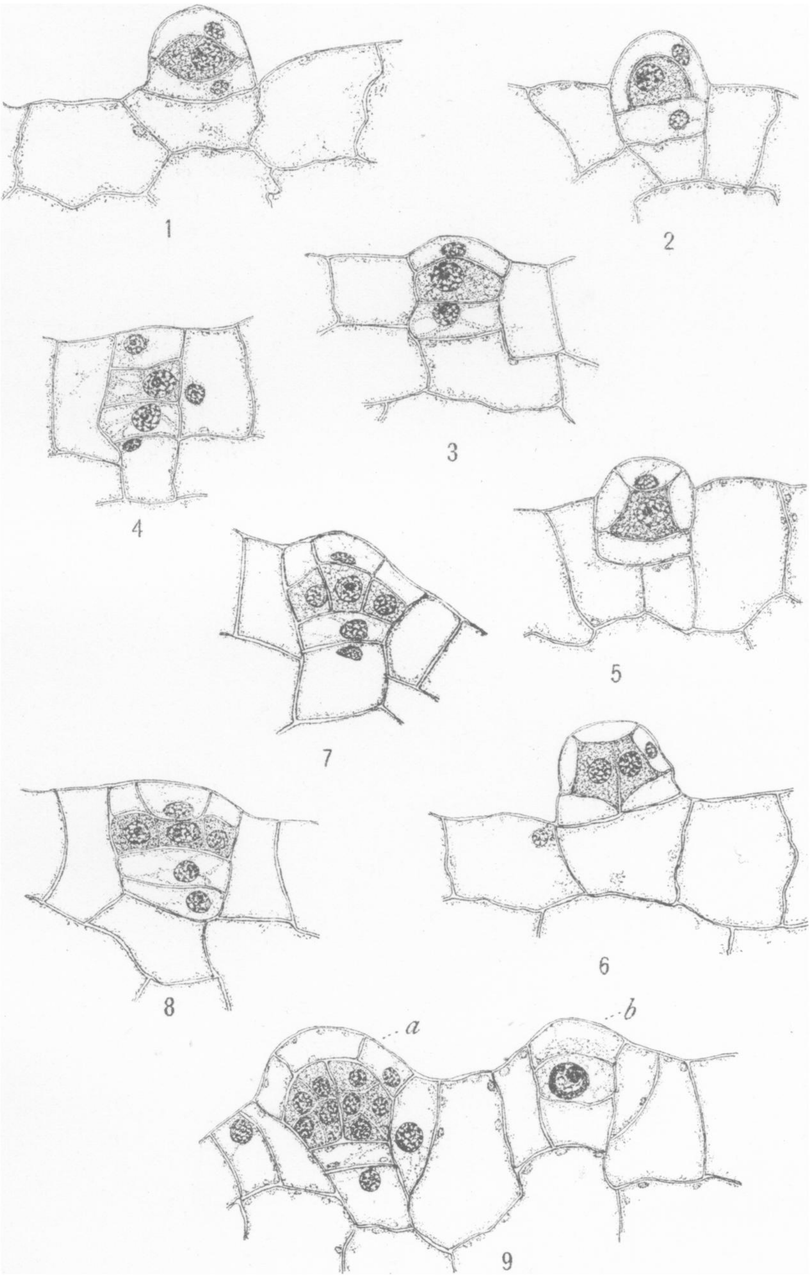
FIG. 10.—The sporogenous cells of an antheridium lying two layers of cells beneath the surface of the prothallium.

FIGS. 11, 12.—Two mature imbedded antheridia; both antheridia and sperms larger than those developed normally.

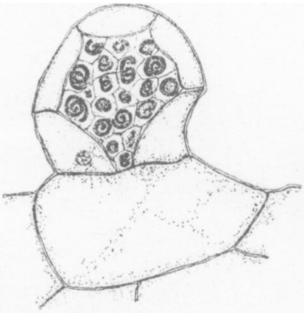
FIG. 13.—A mature, normal antheridium; note position and size as compared with those shown in figs. 11 and 12; these three antheridia were all taken from the same prothallium.

FIG. 14.—An archegonium normal in all respects except that the basal cell is greatly enlarged and contains either an egg or a protoplast which would later have divided to form a second egg and a second ventral canal cell.

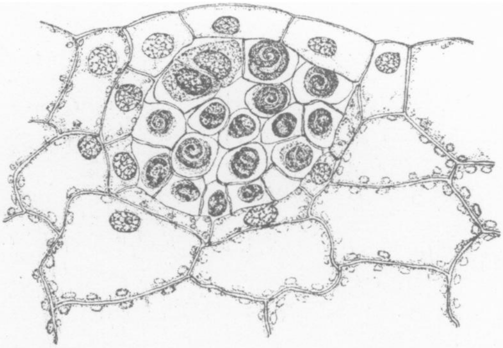
FIG. 15.—An archegonium containing two egg and two ventral canal cells; the second egg and canal cells have evidently been derived from the basal cell.



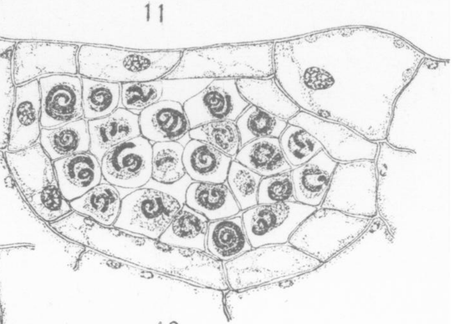
***FERGUSON on IMBEDDED SEXUAL CELLS***



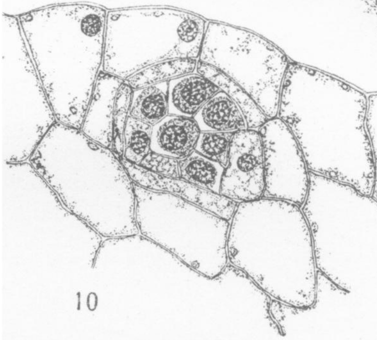
13



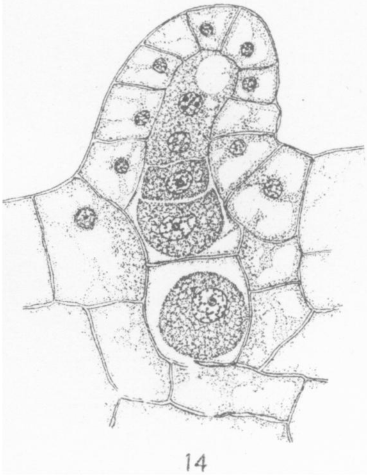
11



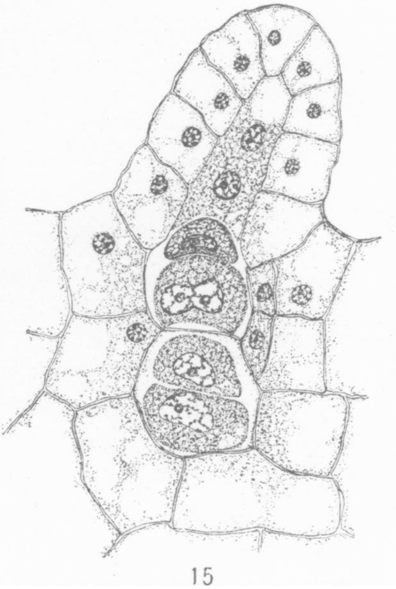
12



10



14



15

*FERGUSON on IMBEDDED SEXUAL CELLS*